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NEIC

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Trip Report

Region 2 Advanced Monitoring 2017

Albany, New York, Area
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INTRODUCTION

The U.S. Environmental Protection Agency's National Enforcement Investigations Center (NEIC) Geospatial Measurement of Air Pollution (GMAP) unit has the capacity to perform facility inspections using EPA draft Other Test Method (OTM) OTM-33 (https://www3.epa.gov/ttn/emc/prelim/otm33.pdf) and draft OTM-33a (https://www3.epa.gov/ttn/emc/prelim/otm33a.pdf). The GMAP unit consists of a mobile vehicle equipped with: an integrated cavity output spectrometer (ICOS) for methane (CH_4) and carbon dioxide (CO_2) measurements; a differential ultraviolet absorption spectrometer (DUVAS) for benzene (BEN), toluene (TOL), ethylbenzene (ETB), m-xylene (XYM), o-xylene (XYO), and p-xylene (XYP) (collectively referred to as BTEX) as well as sulfur dioxide (SO_2) measurements; a photo ionization detector (PID) for total volatile organic compounds (VOCs); a global positioning system (GPS); a compact weather station that provides motion corrected wind speed and direction; and a mechanism for collecting air canister samples.

Data collected while the GMAP unit is in motion can be plotted on Google Earth Pro (GEP) maps to help locate emission sources. Data collected while the GMAP unit is stationary can be used to create bivariate polar plots (http://www.openair-project.org/PDF/OpenAir_clusterFinal.pdf) or weighted mean polar frequency plots (https://www.rdocumentation.org/packages/openair/versions/2.1-0/topics/polarFreq), where wind direction is the direction from the pole, wind speed is distance from the pole, and color represents concentration data. These polar plots can help locate emission sources. Under certain conditions, data collected while the GMAP unit is stationary can be used to estimate the mass emission rate of a source using draft OTM-33a.

A FLIR model GF320 infrared imaging camera was used to attempt to locate sources of emissions found using the GMAP unit. The FLIR camera has a bandpass filter on the detector to limit the image to a narrow band of the infrared spectrum where many hydrocarbons have spectral signatures; this allows the FLIR camera to image gas-phase hydrocarbon emissions. The FLIR camera can also use a high sensitivity mode, in which image subtraction is performed to highlight the movement characteristic of gaseous emissions.

All field sampling, field measurements/monitoring and laboratory measurements described in this report are within the scope of NEIC's ISO/IEC 17025 accreditation issued by the ANSI-ASQ National Accreditation Board (certificate No. AT-1646), except for GMAP IR (ICOS)/UV (DUVAS) and motion-corrected anemometer measurements. NEIC is in the process of validating the GMAP IR/UV measurement activities.

SUMMARY OF ACTIVITIES AND RESULTS

NEIC performed draft OTM-33 air monitoring using the GMAP unit in and around the Albany, New Jersey, area from August 21, 2017, through August 31, 2017. A total of 104 GMAP mapping runs were conducted to measure for VOCs, methane, BTEX, and SO_2. One background

air canister and two air canister samples and were collected. The routes traversed for all mapping runs are depicted in **Figure 1**, many of which were repeated several times over several days. The colors shown in this mapping overview are intended only to show the monitoring locations.

The air samples that were collected were analyzed at the NEIC laboratory in Denver, Colorado, during September 2017.

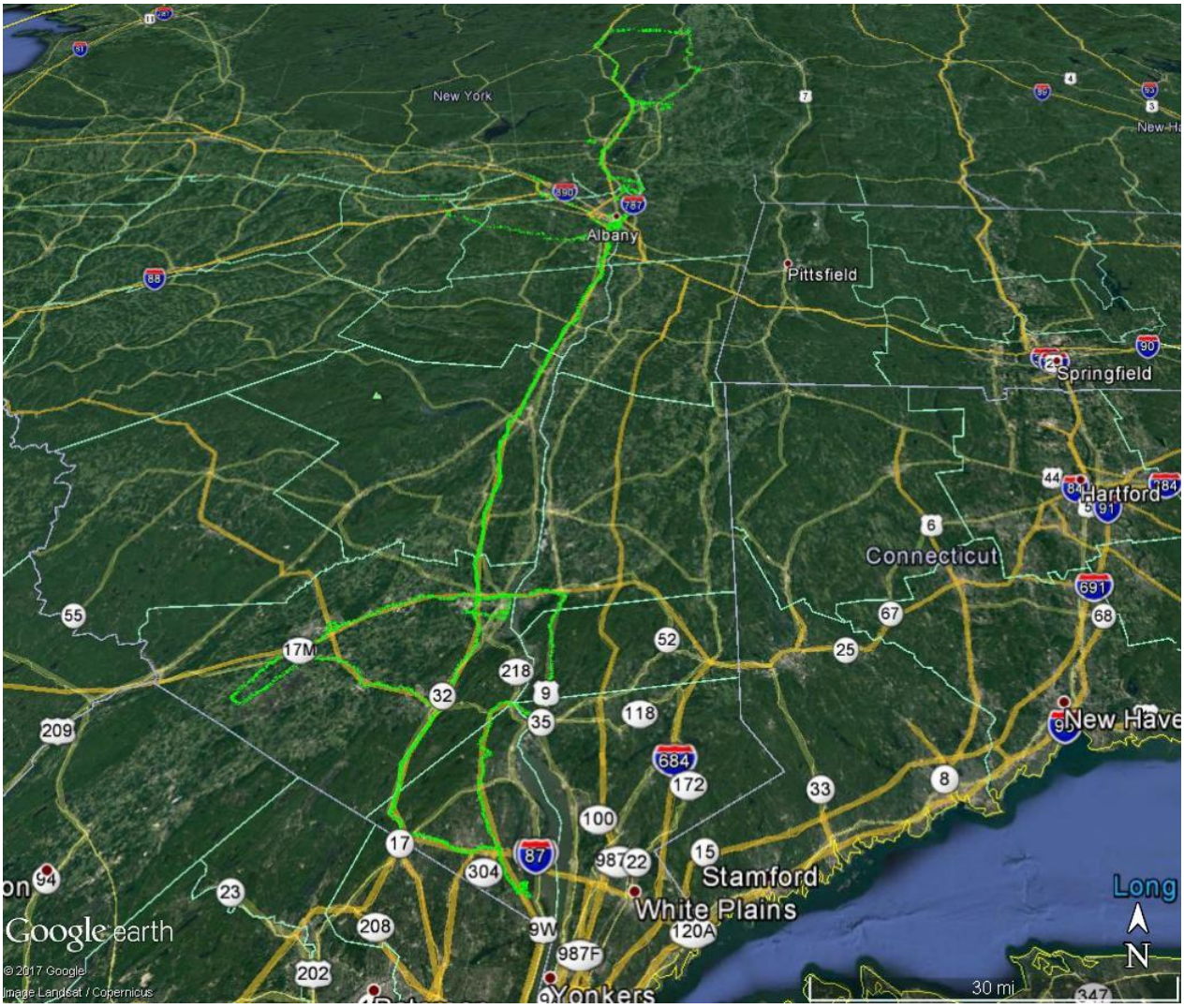

Figure 1. Albany, New York, GMAP routes
Region 2 Advanced Monitoring 2017
Albany New York, Area

FIELD ACTIVITIES

GMAP

NEIC conducted all GMAP monitoring from August 21, 2017, through August 31, 2017. All GMAP files and air canister samples were collected under the direct supervision of NEIC project manager Bill Squier. To easily evaluate significant quantities of data generated by the GMAP unit, analyte concentration values are displayed on GEP map plots for mapping files or on polar plots for stationary files. Concentration readings for each analyte are generated approximately every second, and these data are recorded, along with the corresponding GPS and meteorological data.

For each mapping file containing an elevated analyte concentration, the concentration data are converted into color bar graphs which are overlaid on the map plots. For each individual mapping run, the highest analyte concentrations are displayed in red and the lowest concentrations are displayed in green on the color bar graphs. Concentration values lower than the mapping scale minimum (green) value used appear as green lines. Concentrations higher than the mapping scale maximum (red) value used appear as proportionally taller red bars. The bars correspond to a 2.5-meter distance travelled by the GMAP vehicle; the concentration value shown on the bar is the highest concentration value recorded inside that distance. Where available, wind arrows are provided for each concentration bar. The direction of the arrow is the wind direction, and the length of the arrow is proportional to the wind speed. Due to aerodynamic interference, wind data are not available when the vehicle exceeds 30 miles per hour (mph).

Overview of GMAP Mapping Surveys

NEIC collected GMAP measurements for methane, BTEX, and SO_2 from August 21, 2017, through August 31, 2017. As mentioned earlier, concentration readings for each analyte (CH_4, VOCs, BTEX, and SO_2) are generated approximately every second. The three GMAP instruments, ICOS, DUVAS, and PID, are treated differently for GEP mapping purposes due to differences in the way data must be processed to generate representative maps of the data.

The ICOS CH_4 concentrations are reported in parts per million volume (ppm) and show an atmospheric background concentration of approximately 1.9 ppm. The signal from CH_4 emission sources comprise readings above background. There are many sources of CH_4 emissions, not all of which are areas for concern. To avoid generating maps that do not warrant further investigation, mapping scales for CH_4 are fixed at 2 ppm minimum (green) and 4 ppm maximum (red) unless otherwise noted. All CH_4 maps are created, regardless of their maximum value, so that areas surveyed without significant emissions can be seen on the maps.

The ICOS CO_2 concentrations are reported in ppm and show a geographically variable atmospheric background concentration of approximately 400 ppm. CO_2 concentrations are only reported as necessary to provide source characterization data using mapping scales that are chosen

for source characterization purposes for each map generated. CO_2 maps may be necessary to distinguish between VOC readings between stationary non-combustion sources (which have no CO_2 emissions) and interfering mobile combustion sources (which have CO_2 emissions). CO_2 maps may be useful in distinguishing landfill CH_4 readings (which would also have a CO_2 component) from non-landfill CH_4 sources. No CO_2 maps are included in this report. CO_2 data was used to inform the "Possible Causes of Elevated Readings" column in the "Elevated GMAP Readings" (Table 2).

DUVAS BTEX and SO_2 concentrations are reported in parts per billion volume (ppb). Because of the nature of the way the DUVAS instrument generates concentration data, DUVAS analyte concentrations require special processing. 40 Code of Federal Regulations (CFR) Part 136 Appendix B, "Definition and Procedure for the Determination of the Method Detection Limit," is used to determine the 95 percent upper confidence limit (UCL) of the method detection limit (MDL) for all GMAP BTEX and SO_2 concentration values. Positive zero offset values calculated by averaging instrument zero checks performed at the beginning and end of each sampling day are added to the UCL to determine each day's adjusted UCL for each BTEX analyte and for SO_2. BTEX and SO_2 zero offset adjustments are necessary due to limitations of the DUVAS instrument. Each BTEX and SO_2 analyte's daily adjusted UCL, UCL, and MDL are presented in **Table 1**. The scale used for each BTEX and SO_2 analyte in the GEP maps is fixed for each sampling day at a minimum (green) equal to the MDL plus positive daily zero offsets to a maximum (red) equal to two times the UCL plus positive daily zero offsets. Values greater than 2 times the adjusted UCL plus positive daily zero offsets appear as proportionally taller red bars. The "Elevated GMAP Readings" (Table 2) contains all BTEX and SO_2 values above the daily adjusted UCL.

Table 1. Daily GMAP Adjusted UCL Region 2 Advanced Monitoring 2017 Albany, New York, Area							
	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	o-Xylene (ppb)	m-Xylene (ppb)	p-Xylene (ppb)	SO_2 (ppb)
MDL	4	12	12	27	16	5	34
UCL	9	27	26	59	34	10	75
8/21/2017	10	27	36	59	34	10	82
8/22/2017	10	27	35	59	34	10	82
8/23/2017	11	27	26	59	34	10	88
8/24/2017	13	27	28	59	34	10	91
8/25/2017	9	27	26	59	34	10	88
8/26/2017	10	27	29	59	34	10	84
8/27/2017	11	27	34	59	34	10	75
8/28/2017	9	27	35	59	34	10	78
8/29/2017	11	27	27	61	34	10	95
8/30/2017	10	27	26	59	34	10	91
8/31/2017	11	27	29	59	34	10	87

The PID is calibrated with isobutylene, and all reported values for VOCs are in ppb as isobutylene. Due to wide natural variances in background concentration and to the many sources of VOCs, not all of which are areas for concern, VOCs are not mapped unless there is a difference between the highest and lowest VOC value in a file of at least 200 ppb, unless otherwise noted. VOC map scales are set to the file minimum value plus 100 for the map scale minimum (green) and the file minimum value plus 300 for the map scale maximum (red) unless otherwise noted.

As discussed earlier, the concentration values derived from the GMAP unit mapping files are presented in the GEP maps. These maps are saved as Google Earth keyhole markup language (kml) files. For each day that GMAP mapping files were collected, a separate kml was created containing all CH_4 concentrations and those CO_2, BTEX, and SO_2 concentrations noted in the "Elevated GMAP Readings" (Table 2). All VOC mapping files with a concentration noted in the "Elevated GMAP Readings" (Table 2) have a unique kml.

Elevated Readings

Maximum concentration readings in each file collected by the GMAP unit are shown in **Table 2**. Only concentrations that have GEP maps or polar plots are shown in **Table 2**; they can be considered as concentrations elevated above background levels. Mapping concentrations meeting the threshold to appear as red bars in the kml files (as defined in "Overview of GMAP Mapping Surveys") are highlighted red in **Table 2**. The kml files for all concentrations reported in **Table 2** are in **Appendix A**.

Table 2. Elevated GMAP Readings
Region 2 Advanced Monitoring 2017
Albany, New York, Area

Filename	Methane (ppm)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	o-Xylene (ppb)	m-Xylene (ppb)	p-Xylene (ppb)	Sulfur Dioxide (ppb)	Delta VOC (ppb)	Possible causes of Elevated Readings
170821_MA01	3.49								390	VOC reading due to changing PID temperature.
170821_MA02	2.62									
170821_MA03	2.47								693	VOCs pooling in industrial area along river due to low wind average of SSE<2.5 mph.
170821_MA04	2.58								417	VOCs pooling in industrial area along river due to low wind average of SSE<5 mph.
170821_MA05	2.20								598	VOCs pooling in industrial area along river due to low wind average of SW<2.2 mph.
170821_MA06	3.01			40				87	363	ETB, SO_2 noise outliers. VOCs pooling in industrial area along river due to low wind average of S< 2.8 mph.
170822_MA01	2.17									
170822_MA02	2.10									
170822_MA03	2.15	10			60		12			BTEX noise outliers.
170822_MA04	3.37				78				692	Finch Paper, Glens Falls, New York. Traffic. Highest VOC reading at gas station.
170822_MA05	2.04	12		42				91	228	BEN, ETB Ball Metal, Saratoga Springs, New York, or noise outlier. VOCs from mobile sources.
170823_MA01	3.77								526	Norlite Corp, Cohoes, New York. Wind average SSW<1.2 mph.
170823_MA02	2.18									
170823_MA03	14.16									Town of Colonie Landfill, Cohoes, New York (TCL).
170823_MA04	4.32									TCL
170823_MA05	3.01[1]								301[2]	TCL
170823_MA06	2.43								255	TCL
170824_MA01	2.53				67				231	XYO noise outlier. VOC background variations.
170824_MA02	2.06				60		12			Noise outliers.
170824_MA03	2.47									
170824_MA04	4.59								752	SI Group, Rotterdam Junction, New York.
170824_MA05	2.54								8366[2]	False VOC reading.[3]
170825_MA01	2.18								521	VOC reading due to changing PID temperature.

Table 2. Elevated GMAP Readings
Region 2 Advanced Monitoring 2017
Albany, New York, Area

Filename	Methane (ppm)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	o-Xylene (ppb)	m-Xylene (ppb)	p-Xylene (ppb)	Sulfur Dioxide (ppb)	Delta VOC (ppb)	Possible causes of Elevated Readings
170825_MA02	2.40								623	Momentive Performance Materials, Waterford, New York (MPM).
170825_MA03	2.64	11	48						13867	MPM
170825_MA04	1.99									
170825_MA05	2.09	11							10498	MPM
170825_MA06[4]	2.16								5767	MPM
170825_MA07	1.99								379	MPM
170825_MA08	2.00								311	MPM
170825_MA09	2.08									
170825_MA10	2.12									
170825_MA11	1.96									
170825_MA12	1.94									
170825_MA13	1.99									
170825_MA14	2.51									
170825_MA15	2.15									
170825_MA16	2.70								7241[2]	False VOC reading.[3]
170826_MA01	4.12									Undetermined.
170826_MA02	2.27								244	VOCs pooling in industrial area along river due to low wind average of NNW<3.6 mph.
170826_MA03	2.52									
170826_MA04	2.15									
170826_MA05	2.60									
170826_MA06	2.06									
170826_MA07	8.32								9794[2]	CH_4 undetermined. False VOC reading.[3]
170827_MA01	2.60								736	VOCs decreasing over time and background variations.
170827_MA02	2.15								336	VOCs pooling in industrial area due to low wind average of NE<3.1 mph.
170827_MA03	2.34									
170827_MA04	2.06							77		SO_2 noise outlier.
170827_MA05	2.38									
170827_MA06	2.36									
170827_MA07	2.10									
170827_MA08	3.11									
170827_MA09	2.03									

Table 2. Elevated GMAP Readings
Region 2 Advanced Monitoring 2017
Albany, New York, Area

Filename	Methane (ppm)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	o-Xylene (ppb)	m-Xylene (ppb)	p-Xylene (ppb)	Sulfur Dioxide (ppb)	Delta VOC (ppb)	Possible causes of Elevated Readings
170827_MA10	2.14								248	Undetermined.
170828_MA01	2.68	10							811	BEN mobile source. VOC high reading mobile source. VOC background variations.
170828_MA02	2.07								275[2]	VOC reading due to changing PID temperature.
170828_MA03	3.10								378	VOC reading due to changing PID temperature.
170828_MA04	1.98								257[2]	VOC reading due to changing PID temperature.
170828_MA05	2.02								310	VOC reading due to changing PID temperature.
170828_MA06	2.14									
170828_MA07	2.02								258	Undetermined.
170828_MA08	2.00									
170828_MA09	1.95								226	VOC reading due to changing PID temperature.
170828_MA10	2.16								303	Global Terminal, New Windsor, New York.
170829_MA01	2.24									
170829_MA02	3.08									
170829_MA03	3.04									
170829_MA04	2.75									
170829_MA05	2.66									
170829_MA06	2.84								211	Mobile sources.
170829_MA07	7.82						10			CH_4 TCL. XYP noise outlier.
170829_MA08	2.63						11			Noise outlier.
170829_MA09	2.67						13			Noise outlier.
170829_MA10	2.91				63		11			BTEX noise outliers.
170829_MA11	2.81								201	VOCs pooling in industrial area along river due to low wind average of SE<0.7 mph.
170829_MA12	2.27									
170829_MA13	2.40									
170829_MA14	2.66								229	Cenex Rensselaer Terminal, Rensselaer, New York.
170829_MA15	2.70				63				584	XYO mobile source. VOC high reading from Sprague Energy, Rensselaer, New York.
170829_MA16	2.28								293[2]	Undetermined.

Table 2. Elevated GMAP Readings
Region 2 Advanced Monitoring 2017
Albany, New York, Area

Filename	Methane (ppm)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	o-Xylene (ppb)	m-Xylene (ppb)	p-Xylene (ppb)	Sulfur Dioxide (ppb)	Delta VOC (ppb)	Possible causes of Elevated Readings
170829_MA17	2.32								300	VOC reading due to changing PID temperature.
170830_MA01	2.27									
170830_MA02	6.27								316	CH_4 undetermined. VOC from North Albany Terminal Company, Glenmont, New York.
170830_MA03	2.05									
170830_MA04	2.07			27						Noise outlier. Aluf Plastics, Orangeburg, New York (Aluf).
170830_MA05	2.03		178	47					366	Avery Dennison, Orangeburg, New York (AD). Aluf.
170830_MA06	1.97		28							AD
170830_MA07	1.97		45							AD
170830_MA08	5.35									Rockland County Sewage Treatment, Orangeburg, New York (RCST).
170830_MA09	4.12									RCST
170830_MA10	4.41									RCST
170830_MA11	2.07									Aluf
170830_MA12	2.49								9302	False VOC reading.[3]
170831_MA01	2.09									
170831_MA02	2.16									
170831_MA03	2.12									
170831_MA04	2.03								342	Commonwealth Plywood, Whitehall, New York.
170831_MA05	2.69									
170831_MA06	2.60									
170831_MA07	2.05									
170831_MA08	1.97									
170831_MA09	2.17									
170831_MA10	2.39									

Note: NEIC has not evaluated measurement uncertainty for these reported values. Motion-corrected wind speed and direction data cannot be verified.

[1] 170823_MA05_Max_CH4 was created with max scale value of 2.5 for CH_4 to better depict the downwind CH_4 plume from Colonie Landfill.

[2] Highest reading data at the end of a mapping file taken when the GMAP is motionless will produce a high concentration icon but will not produce a representative concentration bar on the resulting map.

[3] Data was still being collected when PID was removed from sample line for calibration causing a spike in the recorded data.

Table 2. Elevated GMAP Readings
Region 2 Advanced Monitoring 2017
Albany, New York, Area

Filename	Methane (ppm)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	o-Xylene (ppb)	m-Xylene (ppb)	p-Xylene (ppb)	Sulfur Dioxide (ppb)	Delta VOC (ppb)	Possible causes of Elevated Readings

[4] Air canisters collected.

Reading GMAP Results

GEP is a free software program that may be downloaded and installed from the internet. Controls in the upper right of the GEP image allow the user to turn the view and to set the magnification so that the image can be seen from the best perspective. After the software is installed, double-clicking a kml file will open the file in GEP under "Temporary Places" in the "Places" box on the left side of the screen. **Figure 2** is a screen shot of a GEP image showing selected data from the kml file 170823_Max.kml, created for the August 23, 2017, sampling day. Double-clicking a second kml file will open that file, along with any others already open in GEP.

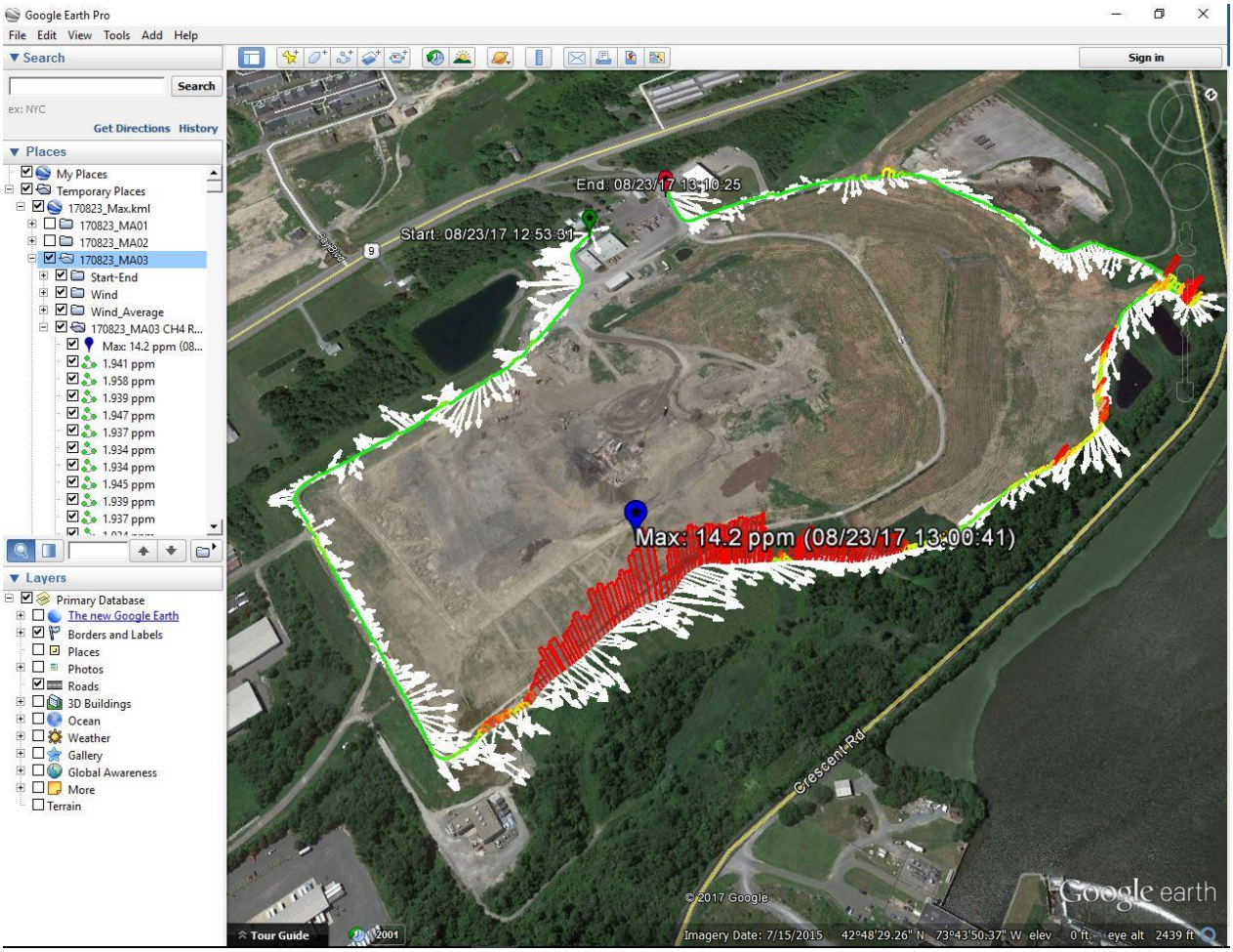

Figure 2. Screen shot of Google Earth Pro image displaying GMAP data,
Town of Colonie Landfill, Colonie, New York
Region 2 Next Generation Monitoring 2017
Albany, New York Area

Note: NEIC has not evaluated measurement uncertainty for these reported values.

Note the check boxes and dropdown arrows in the "Places" box. The dropdown arrows control the level of information that can be viewed in the "Places" box. **Figure 2** shows the individual mapping files located within the daily file; information for the third map run is visible. The check boxes control what is displayed on the GEP image. In **Figure 2**, for 170823_MA03, start-end icons, wind arrows, average wind arrow (located at the end icon), maximum value icon, and CH4 concentration bars are displayed. If the concentration data is displayed in the "Places" box, clicking a concentration bar in the image will highlight the concentration value in the "Places" box. Clicking the drop-down arrow next to the wind check box and clicking on an individual wind arrow in the image would highlight the wind speed and direction for that wind arrow.

Upon opening 170823_Max.kml, all concentration maps, icons, and wind data are displayed simultaneously. However, all data for the view in **Figure 2** have been turned off by clicking the check box next to 170823_Max.kml so that the third CH_4 map for this day and its wind data can be examined more closely. This map shows the highest concentration of CH_4 measured in this mapping file. The concentration maximum scale is fixed such that it will appear as a red bar with a height of 25 meters at two times the UCL plus positive daily zero offsets. In

Figure 2, all CH_4 concentrations greater than the maximum-scale value are red with a height taller than 25 meters in proportion to the concentration. The green concentration bars represent values of the MDL plus positive daily zero offsets or less and would not represent elevated CH_4 concentrations. For BTEX and SO_2 concentrations, yellow or orange concentration bars represent values that would require some corroborating evidence to establish high confidence that they are true readings and not instrument noise outliers. Corroboration could be the presence of a known source directly upwind, concentration of other compounds at the same place, or red or higher values adjacent to the yellow bar.

GEP has features that allow the user to generate jpeg images from the image on the screen. The user can add icons with labels to the maps. Legends, titles, and other information can be added to the jpeg images.

When the wind direction is changing frequently, a measured concentration may also be from an emitted plume that has been blown back to the source. Large obstructions such as tanks also have wakes that can generate local winds opposite of the prevailing wind direction. Additionally, the wind speed and direction sensor is located on top of the moving vehicle and can be affected by the vehicle wake in some instances. The wind direction is determined using an internal magnetic compass that also may be affected by local magnetic fields. It would be prudent to closely examine all the available data, including concentration maps in the immediate vicinity for all compounds, as well as FLIR video, air canister samples, source characteristics, and polar plots available around a source to decide where further investigation would be warranted. Currently, GMAP data is best used to screen for areas where further investigation using more traditional leak detection and repair (LDAR) techniques will be most useful.

AIR CANISTERS

Three air canister samples were collected in the Albany, New York, Area. Two of the canisters were collected simultaneously during the mapping run associated with GMAP file 170825_MA06 at Momentive Performance Materials, Waterford, New York (Station 1), and the third canister was collected as a background sample during the post-mapping calibration associated with GMAP file 170831_CA02 at the TownPlace Suites, Albany, New York (Station 2). The three air canister samples were analyzed at the NEIC laboratory during September, 2017 using gas chromatography-mass spectrometry (GC-MS) for TO-15 volatile organic compounds. Reported compounds are quantitative results with uncertainties shown in the laboratory report. Uncertainty was estimated based on EPA Compendium Method TO-15 method acceptance criteria. The analytical results for the air canister samples collected and analyzed at the NEIC laboratory are contained in **Appendix B**.